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ON THE
COMPONENT PARTS
OF
Animal Matters.

BRITISH MUSEUM

A FEW
OBSERVATIONS
ON THE
COMPONENT PARTS
OF
ANIMAL MATTERS;
AND ON
THEIR CONVERSION
INTO A
Substance
RESEMBLING
SPERMACETI.

BY
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BRITISH MUSEUM

OBSERVATIONS

ON THE

Component Parts of Animal Subſtances, &c.

BEFORE we enter into a deſcription of the obſervations and experiments which we have to offer on the compoſition of animal matters, we think it neceſſary to give ſome account of the appearances, which theſe ſubſtances exhibit, when they are ſeparated from bodies recently dead.

In every fibre belonging to the animal ſyſtem, even in the humid muſcular fibre, there is a contractile and elaſtic power, which preſerves the fibre in its natural ſtate, which reſiſts over diſtenſion, and which reſtores it to its proper dimenſions when the ſtretching power is removed.

This property is not confined to animal matters, for the gluten of vegetables poſſeſſes it in a very eminent degree.

This force, with which animal and vegetable matters bring their elementary principles into the cloſeſt contact that their ſtructure will admit of, ſeems not to ariſe from the powers of animation, for it is exerted for many days after the death of the animal; indeed if care be taken it may be preſerved for any length of time, as is fully evinced by the ſtrings of muſical inſtruments commonly called catgut, and in ſhort by all thoſe ſubſtances which are prepared from animals and vegetables, and which poſſeſs an elaſtic force.

This power is of the moſt eſſential importance to the living animal, but as we are confined to the conſideration only of dead animal matter, we muſt omit ſaying any thing on that ſubject in the preſent inquiry.

The moſt common obſervers muſt have ſeen this power exerted in numberleſs inſtances; even after meat has been expoſed to a violent heat, as in cooking, the receding of the meat on each ſide of the knife on the firſt cutting into it, ariſes from the exertion of this power.

One of the firſt ſigns of putrefaction is announced by a diminution of this elaſtic force, and when animal ſubſtances have undergone a thorough putrefaction, this power entirely ceaſes.—As we ſhall have occaſion to refer to the phenomena attending putrefaction in another part of this work, we will now paſs on to the appearances of muſcular fibres.

In every muſcle we find long ſoft threads or fibres, ſomewhat elaſtic or extenſible, diſpoſed in general parallel to each other. Theſe fibres are connected together by a looſe cellular net-work, which contains ſome fat. This cellular ſubſtance is thicker in ſome parts than in others, forming a diſtinct ſeparation betwen the ſeveral muſcles.

When putrefaction commences theſe parts are confounded, their primary principles are diſunited, and new bodies are formed according to the determination of the arrangement between the chemical elective attractions ſubſiſting between theſe ſeveral principles. During life the powers of chemical affinity ſeem to be ſuſpended, but when animation ceaſes, chemical union ſoon begins to exert its influence.

Within the cells of the cellular ſubſtance is contained an oily fluid more or leſs thick, differing in quantity in different animals and in different parts of the ſame animal, which, when in a concrete ſtate, is known under the name of fat. The fat in different animals differs eſſentially from the fat in the human ſubject, and many different kinds of fat exiſt frequently in the ſame body.

There have been many conteſts in the phyſiological world reſpecting the mode in which the fat is formed in the body, all of which have not yet ſettled the true nature and extent of this ſecretion. The uſes which this ſubſtance anſwers in the animal economy, are too obvious to cauſe much difference of opinion, but a correct knowledge of its mode of formation is ſtill left for future phyſiologiſts to diſcover.

We ſhall now attempt an explanation of ſome of the properties of animal ſubſtances, of the mode of their compoſition, and of ſome peculiar changes they may be made to undergo when expoſed to the influence of ſome circumſtances.

It is a matter of great curioſity to obſerve, after any fact has been well aſcertained, how many things might have led to a much earlier inveſtigation; particularly ſo had the writings of many great men been equally examined, with thoſe obſervations, which, though apparently very trifling, have often excited general attention. The converſion of animal muſcle into a fatty matter gives a very ſtriking example.

The celebrated Sir Thomas Brown, in his learned and very curious treatiſe intitled Hydriotaphia, aſſures us, that he has found a ſoap-like ſubſtance in an hydropical body. His words are as follow, viz. " In an hydropical body, ten years " buried in a church yard, we met with a fat con- " cretion, where the nitre of the earth, and the

" ſalt and lixivious liquor of the body, had coagulated large lumps of fat into the conſiſtence " of the hardeſt caſtile ſoap; whereof part re- " maineth with us."

Lord Bacon, in his work intitled Sylva Sylvarum, alſo mentions this curious circumſtance, " You may turn (almoſt) all fleſh into a fatty ſubſtance; if you take fleſh and cut it in pieces, " and put the pieces in a glaſs covered with parchment; and ſo let the glaſs ſtand ſix or ſeven " hours in boiling water. It may be an experiment of profit for making greaſe or fat for many " purpoſes; but then it muſt be made of ſuch " fleſh as is not edible, as horſes, dogs, bears, " foxes, badgers, &c."

Animal muſcle, having loſt its living principle, has been generally ſuppoſed to undergo that kind of decompoſition only, which has been known by the name of the putrefactive fermentation. Since the diſcovery of the bodies in the Cimetiére des Innocens at Paris, this ſubject has been more attended to; and a ſubſtance much reſembling ſpermaceti, is now known to be formed by combinations which take place between the animal fleſh and water.

If you put fleſh under water and let it ſtay ſome time, it will get very offenſive, and the putrefactive fermentation will in ſome meaſure moſt aſſuredly take place. This ſeems to have been the reaſon why the ſubſtance remaining in the water had not been more accurately examined, it being imagined that as this decompoſition had commenced, the whole would be changed in the ſame manner. It would appear ſtrange, if the ſame ſubſtance, expoſed to the action of two ſuch different bodies as air and water, ſhould undergo preciſely the ſame change. That they do not has been lately proved by many experiments: and that the putrefactive fermentation is not at all neceſſary in the formation of this fatty matter, I think ſome of the following experiments will ſhew:

After having ſeen ſome of the matter found in the Cimetiére des Innocens at Paris, I concluded that in ſome ſituations the ſame kind of ſubſtance might be eaſily found; accordingly I examined ſome macerating tubs belonging to anatomical ſchools in London, and I found that in moſt of them the fleſh was nearly changed into this kind of fat.

By the indulgence of Dr. Pegge, the anatomical profeſſor at Oxford, I was permitted to examine the receptacle in which the bodies are depoſited, after he has finiſhed lecturing on them. This place is a hole dug in the ground to the depth of about 13 or 14 feet; and to remove all offenſive ſmell, a little ſtream is turned through it. I found on firſt looking into it, that the fleſh was quite white; and on drawing up the firſt piece, I found it changed in the manner before deſcribed. From this place I have procured at leaſt twelve pounds weight, of a waxy ſubſtance very much reſembling ſpermaceti.

Having ſeen many ſpecimens of different animals, which had been changed under ſomewhat different circumſtances, that is, where ſome had been buried in damp ground, ſome in wet ground and ſome even in water itſelf, I began to ſuſpect that I might bring about the ſame change in a ſhorter time, at leaſt I might determine the time neceſſary for it: with this view the leaneſt part of a rump of beef was confined in a box full of holes, which being tied to a tree near a river, was ſuffered to float in it. On taking this up from time to time, I perceived that it gradually got whiter and whiter, and at the end of a month it was perfectly to appearance changed to a maſs of fatty matter.

From ſome circumſtances I am induced to believe, that it is ſooner converted in running water, than when it is perfectly at reſt; for when the beef was expoſed to the water in the river, a piece of mutton was placed in a reſervoir of water, and I perceived that though the mutton was expoſed for a longer time than the beef, yet it was not ſo thoroughly changed.

. Finding that this ſubſtance was ſo formed, and that I could procure large quantities of it, I tried ſome experiments to purify it; for this purpoſe I took ſeveral pieces of it and melted them; and I found that though they were brought into a cloſer union, yet the fœtid ſmell was as bad as before. After trying ſome unſucceſsful experiments, it occurred to me that if I could add a ſubſtance to it which would unite with the offenſive parts, and not with the fat, I might then get it pure; accordingly I poured ſome nitrous acid upon it, which immediately had the deſired effect; a waxy ſmell was perceived, and on ſeparating and melting it, I got it nearly pure. The nitrous acid turns it yellow, but by ſubmitting it to the action of the oxygenated muriatic acid, I have got it quite white and pure. In the beginning of June 1792, I buried a cow in a place, where from the riſing of the water of a river to ſupply a mill twice a day, it was ſubmitted to the action of running water. On taking this cow up in the December following, I found that where the water was conſtantly running over it, there it was changed into a fatty ſubſtance, but where the water which had acted on the meat could not paſs off, there a very diſagreeable ſmell was ſenſible and the fleſh was not ſo much changed.

A piece of this cow, that was perfectly lean, was ſtuck through with a ſtick, and was faſtened to the bottom of the river; this piece was perfectly changed into a fatty matter, and had loſt its offenſive ſmell.

I have brought about this change in a much ſhorter time, in the following manner:—I took three pieces of lean mutton, and poured on them the three mineral acids, and I perceived that at the end of three days each was much altered; that in the nitrous acid was much ſoftened, and on ſeparating the acid from it, I found it to be exactly the ſame with that which I had before got from the water; that in the muriatic acid was not in that time ſo much altered; the vitriolic acid had turned the other black. From theſe experiments, it appears to me that it is not at all neceſſary that the putrefactive fermentation ſhould take place; on the contrary, that it takes away a great deal of the fleſh which might ſerve for the formation of a greater quantity of this waxy ſubſtance.

I mentioned in a former part of this Treatiſe, that the ſubſtance procured either by means of water, or the nitrous acid, appeared to me to have preciſely the ſame external characters; but I have obſerved ſince, that there is a difference between that which I obtain from animals, and that which is procured from the human ſubject: the former ſeems not diſpoſed to cryſtalize, while the latter aſſumes a very beautiful and regular cryſtaline appearance. I believe, however, that this difference ariſes not ſo much from the nature of the fleſh as the mode in which the fatty matter is prepared, as will be ſhewn hereafter.

The matter which I procured from the human ſubject was melted, into which I plunged a very ſenſible thermometer which ſoon roſe to 160°; it began congealing at 112° and became ſo ſolid at 110° that the thermometer could not eaſily be taken out.

I took ſome of the ſpermaceti of the ſhops, and under the ſame circumſtances I plunged the ſame thermometer into it. It ſoon roſe to 170°; a pellicle was formed on the top of it when at 117°; and it became ſo ſolid at 114° that the thermometer could not eaſily be taken out.

I diſſolved a piece of the ſubſtance, which I had formed by means of water and the nitrous acid, in boiling ſpirit of wine; on cooling this mixture, a great quantity of this waxy matter was ſeparated in the form of beautiful flakes. I could not procure large cryſtals, but the flakes aſſumed a cryſtaline appearance. I put into an earthen retort ſome of this waxy matter, to which I added ſome finely powdered charcoal; on applying a pretty ſtrong fire, a ſmall quantity of an oily fluid came over which concreted on cooling; after which came over a prodigious quantity of thick, white vapours, which were very ſuffocating and offenſive.

I had a copper retort made, for the purpoſe of trying ſome experiments on this matter. I put a ſmall quantity into it, and placed it on a common fire; there came over firſt a limpid fluid like water, without much ſmell; on the addition of more heat, there came over an oily fluid, which ſoon coagulated of a firmer conſiſtence, than when put in, and was coloured of a beautiful green by the copper; this laſt circumſtance proves that it contained no ammonia.

Having procured ſome very pure quickſilver, I took a glaſs which contained about ten pounds of that fluid, with which I filled it; I inverted it in a baſon containing the ſame fluid; I introduced a ſmall piece of lean meat, and alſo a ſmall quantity of water. At the end of about ſix weeks, ſo great a quantity of gas was diſengaged as nearly to occupy the whole of the veſſel; the meat had aſſumed a white appearance. We ſhall hereafter ſee the nature of theſe elaſtic fluids and the manner of compoſition between the primary principles of theſe animal ſubſtances.

Since I mentioned my former experiments on the cow which I had ſubmitted to the action of running water, I have obſerved a few facts relating to the changes which took place. This cow was placed in a ſituation where the water could come twice every day, as before deſcribed; over it ſome looſe earth was thrown. After it had remained ſome time in this place, I uſed frequently to puſh a ſtick through this earth to the cow; every time this was done, there came up a prodigious quantity of air, particularly after I had ſuffered it to remain quiet for a ſhort time. Since I put the cow in this ſituation, I have had two horſes and another cow, placed under the ſame circumſtances; in all of them this diſengagement of air takes place; the air is extremely offenſive.

In the former cow the whole muſcular part ſeemed changed; and from the ſubſtance formed, I have procured a very large quantity of a waxy ſubſtance, by means of the nitrous acid. Though the nitrous acid takes off the greateſt part of the fœtor from the ſubſtance thus formed, yet it gives it a yellow colour, which is with difficulty removed, and a peculiar ſmell, evidently ſimilar to the ſmell of the acid employed, which mere waſhing, and the addition of alkalies, will not entirely remove.

My father, who has been indefatigable in his attempts to whiten this ſubſtance, finds that the following proceſs will make it very pure, and very beautiful, though not ſo white as the ſpermaceti of the ſhops.

The cow which had lain in the water for a year and an half was taken up, and we found that the whole muſcular part was perfectly changed into a white matter; this was broken into ſmall pieces, and was expoſed to the action of the ſun and air for a conſiderable length of time. By theſe means it loſt a great deal of its ſmell, and ſeemed to acquire a firmer conſiſtence. The appearance of this ſubſtance was ſomewhat ſingular; for, on breaking it, we found little filaments running in every direction, exactly ſimilar to the cellular ſubſtance between the muſcular fibres. Theſe pieces were then beaten to a fine powder, and on this powder was poured ſome diluted nitric acid. After the acid had been on it for about an hour, a froth was formed at the top; the acid was then poured off, and the ſubſtance was repeatedly waſhed; it was then melted in hot water and when it concreted it was of a very beautiful ſtraw colour, without the leaſt offenſive ſmell; on the contrary, it had the agreeable ſmell of the beſt ſpermaceti.

May not this ſubſtance be applied as an article of commerce? Great quantities of it may be obtained. It burns with a fine flame; and dead animals, which at preſent are of little or no uſe, may be changed into it. I am very ſorry it has not been in my power to aſcertain the preciſe quantity which may be obtained from a given quantity of fleſh; but from what I have obtained, I can ſay it would be very conſiderable. The running water carries off a great deal of it, but that might be obviated by means of ſtrainers. Moreover, that which is carried off by the water is the pureſt, and I always take care to get as much as poſſible of it, becauſe I find it gives me leſs trouble in purifying it.

The water over the animals, and for ſome diſtance round them, is covered with a very beautiful pellicle, which is in general white; ſometimes it refracts the ſun's rays, producing the priſmatic colours.

Fiſh may be alſo changed; and I remember a paſſage in ſome old Author, whoſe name I cannot recollect, in which he mentions a circumſtance where ſomething of this kind happened in a whale. He ſays, that after this fiſh has been putrefying on the ſhore ſome time, the people have a ſecret by which they can procure and purify lumps, which they find to be ſimilar to the ſpermaceti which they get in the uſual way.

I have heard from many people, obſervations which they had made where this ſubſtance had been formed; but as the circumſtances were the ſame as thoſe above mentioned, I ſhall forbear giving additional trouble.

On ſeeing a body opened ſome time ago, where there was a great collection of water in the cavity of the thorax, I obſerved that the ſurface of the lungs was covered with a whitiſh cruſt. I remarked to a friend, that I thought this cruſt was owing to ſome combinations which had taken place between the lungs or pleura, and the ſerous fluid effuſed, ſimilar to what I had obſerved between fleſh and water; or that the ſerous fluid had acted on the coagulable matter, and had produced a ſimilar change.

Dr. Cleghorn mentions a circumſtance, which in ſome meaſure ſeems to agree with the obſervation then made. As the fact is a curious one, I ſhall ſubjoin the following extract. He is ſpeaking of abſceſſes formed in the lungs:

"These abſceſſes had ſometimes emptied them-
"ſelves into the cavity of the thorax, ſo that the
"lungs floated in purulent ſerum; their external
"membrane, and likewiſe the pleura, being
"greatly thickened, and converted as it were
"into a white cruſt, like melted tallow grown
"cold."

In a note he ſays, "I am now doubtful if this
"cruſt was the pleura and external coat of the
"lungs, changed from a natural ſtate by ſoaking
"in a purulent fluid, and if it was not altogether
"a preternatural ſubſtance, formed by fluids de-
"poſited on thoſe membranes, and compacted to-
"gether by the motion of the lungs."

Much has been ſaid by many authors on the ſubject of ſecretion. It was at one time thought that it depended on ſome peculiar property of the living principle; and it was thought impoſſible to form any ſecretion but through the medium of ſecreting organs, M. **Fourcroy** has, however, contradicted this by the experiment where he forms bile. Spermaceti is an animal ſubſtance, ſecreted in a particular ſpecies of whale; and the ſubſtance which is formed in the foregoing experiments as far as I can judge, agrees with it in moſt particulars.

M. **Fourcroy** ſays that M. **Poulletier de la Salle** found a cryſtalized inflammable ſubſtance ſimilar to ſpermaceti, in biliary calculi. May not the ſuety matter in ſteatomatous tumours ariſe from ſomething of this kind?

By attending to the various ſecretions of the body, by examining their compoſition in the healthy and morbid ſtates of the ſyſtem, may we not expect to derive great advantages, particularly when accurate experiments are applied towards the relief of diſeaſe?'

We labour under more diſadvantages in the analyſis of animal matters, than in any other part of chemiſtry; we receive but little aſſiſtance from the labours of the older chemiſts, who were contented with barely diſtilling animal ſubſtances by a naked fire, by which means they produced ſubſtances rather the conſequence of the fire than the real component parts into which they intended to reſolve them.

Phlegm, an oily volatile alkaline ſpirit, a groſs ponderous animal oil, and a caput mortuum were the chief products of ſuch inveſtigations.

That there exiſts in all animal matters a certain quantity of water muſt be admitted by every one, but that water is often decompoſed and recompoſed both in the putrefactive fermentation and other kinds of decompoſition, has I think been ſufficiently proved by the very accurate experiments of ſome modern philoſophers; that the alkali does not originally reſide in animal ſubſtances, is fully evinced by the accurate and concluſive experiments of M. BERTHOLLET; that much of the oily or fatty parts which are obtained by treating theſe ſubſtances in a particular way with ſome agents, ariſes from peculiar combinations between thoſe matters and the ſubſtances uſed, will I preſume, be farther ſhewn by the experiments I am about to relate.

Many circumſtances have occurred to retard this part of ſcience; the danger which has been ſuppoſed to attend the proceſs of the ſpontaneous decompoſition, the numerous and often contradictory reſults which are found to be the conſequences of varied modes of analyſis, and the imperfect ſtate from which chemical inveſtigations have not long been reſcued, are of themſelves ſufficient to account for our ignorance of the ſubject.

Since then, ſo little has been done on the ſubject, I come forward with the greateſt diffidence, at the ſame time being well aſſured that all allowance will be granted if I ſhould fail in attempting a work in which ſo little is at preſent known. At all events, if in the proſecution of the ſubject ſome new facts be gained, I ſhall not think my time or labour either loſt or miſapplied.

Since the mode of confining and examining elaſtic fluids has arrived at its preſent degree of perfection, chemical inquiries have become much more numerous, and our knowledge of the component parts of many ſubſtances much more complete. The accuracy with which many pneumatical experiments have lately been conducted fully evinces this truth. Many ſubſtances, before the introduction of pneumatic chemiſtry, were either perfectly unknown or totally diſregarded.

When the ſeveral parts of organized matter have loſt that principle which is conſtantly employed during life in preſerving and keeping them from decay, we find them when expoſed to the atmoſphere, ſoon undergoing a change their component parts are diſunited, new combinations

binations take place and the properties which formerly characterized them totally vaniſh.

Theſe circumſtances mark the progreſs of the putrefactive fermentation, which may be haſtened, retarded or even ſuſpended by the action of other ſubſtances, or by the temperature or quality of the air to which they are expoſed.

We know from the experiments of Dr. MACBRIDE that the carbonic acid gas will conſiderably retard the progreſs of putrefaction; while the expoſing animal matters to a ſomewhat increaſed temperature will greatly promote the proceſs; by keeping fleſh from the contact of the air the progreſs of putrefaction is alſo much retarded.

While a certain balance of affinities is preſerved, we find a permanency in the qualities of bodies, but on the diſſolving this, a diſunion of parts and production of new ſubſtances take place. We obſerve that an increaſed temperature will frequently effect this in the decompoſition of organized matter, the force of diſunion being augmented in proportion to the increaſe of the temperature. The products alſo which reſult from the decompoſition are much affected by the degree of heat which attends the proceſs, for the affinities which exiſt between the parts ſeparated are all arranged through the influence of that moſt penetrating medium. We obſerve in cold weather that the fetor attending putrefaction is not by any means ſo great or powerful as under the influence of the ſummer's ſun. The pickling, ſalting, and preſerving proviſions, clearly prove that the addition of ſome ſubſtances will greatly retard the progreſs of putrefaction.

The obſervations of many modern philoſophers clearly point out that the phenomena attending the putrefactive fermentation are cauſed by the operation of very complicated affinities; theſe affinities are ſo very weak even between the remote component parts, that in order to underſtand the ſubject we muſt have recourſe to them as the foundation of every theory which can poſſibly be made on a ſubject ſo intricate as the preſent. In the analyſis of moſt other ſubſtances we find that the proximate component parts may be eaſily ſeparated, while the remote remain undiſturbed.

M. LAVOISIER in the HISTOIRE DE L'ACADEMIE DES SCIENCES for 1786 has ſhewn, that water is decompoſed by animal and vegetable ſubſtances. He proves that this decompoſition takes place in the ſeveral proceſſes to which animal and vegetable ſubſtances are ſubmitted, and he adds that the obſervations which he has made on vegetable ſubſtances will apply to animal matters; theſe, he obſerves are equally the reſult of a triple combination of oxygene, hydrogene and carbone; they contain neither the water, the carbonic acid, nor the oil already formed, but their elements or component parts are contained in them. Theſe phenomena are, he obſerves, ſtill more complicated ſince they poſſeſs a fourth principle, Azote, which combining with the hydrogene forms the ammonia or volatile alkali. He goes on with ſaying that the obſervations made by M. FOURCROY on the converſion of the muſcular parts into a fatty matter, after the lapſe of a very conſiderable time in the Cimetieres, alſo ſupport this theory; the oxygene, he obſerves, has been abſtracted by ſome circumſtance, allowing the hydrogene and carbone only to remain, which are the materials that compoſe the fatty matter.

In this place I think it proper to mention a few experiments which I made to aſcertain the effects produced on muſcular fibre by ſubmitting it to the action of the ſeveral gaſſes.

I procured a large quantity of azote by depriving atmoſpheric air of its oxygene by means of the ſulphure of potaſh; into a retort full of this air, the mouth of which was inverted in water, I placed a piece of lean beef, which was laid at the bottom of the globular part ſo as not to be in contact with the water.

I placed in the ſame manner a piece of the ſame beef in another retort which was filled with hydrogene gas procured by means of zinc and diluted ſulphuric acid. After the interval of a few days the fleſh which was expoſed to the azote had aſſumed a dark appearance, its texture appeared broken, and all the external characters marked a haſty progreſs towards putrefaction; the fleſh on the contrary which was expoſed to the hydrogene retained its florid colour without appearing in the ſmalleſt degree putrid.

I ſubmitted ſeveral pieces of lean beef in different veſſels to the action of oxygene gas which I procured from the black oxyde of manganeſe, in all the abſorption was very great. In one experiment 9-10ths or more of the oxygene was abſorbed by the fleſh.

I took two phial bottles, one of which I filled with oxygene gas, the other with atmoſpheric air; into each I placed a piece of lean beef; I put in their ſtoppers and immerſed them in two glaſſes of water: after they had remained in this ſtate for twenty-four hours, I took out their ſtoppers under water, a great quantity of which ruſhed into the bottle which contained the oxygene gas, while much air eſcaped from that which contained atmoſpheric air.

From theſe experiments we learn how eaſily affected and how differently modified the affinities are, which ſubſiſt in the compoſition of the muſcular fibre. Azote, we have found by many experiments to be particularly ſavourable to the putrefactive fermentation, that though it haſtens this proceſs we yet find it increaſed in bulk; this alſo happens when azote is united with oxygene as in the atmoſpheric air; but when oxygene alone is added we find it rapidly abſorbed and the fleſh inſtead of becoming putrid aſſumes a white appearance.

Were chemical inſtruments ſufficiently delicate or our mode of examining theſe ſubſtances ſo correct as to enable us to aſcertain the preciſe point where theſe numerous affinities ſeparate in order to obey thoſe which have a greater power of attraction, many very uſeful and important diſcoveries would moſt aſſuredly be the conſequence; the oxygene of the water might then, probably be directed ſo as to unite with the azote of the fleſh, whereby we might obtain large quantities of the nitrous acid; or the hydrogene of the water might be combined with the azote, by which means very large quantities of pure oxygene might be evolved.

We always obſerve when fleſh is kept for ſome time under water that there is a great quantity of hydrogene gas diſengaged; this hydrogene unites in the putrefactive fermentation according to the experiments of M. Berthollet with the azote contained in the animal ſubſtance and forms with it ammonia; this laſt ſubſtance is always formed in the ſpontaneous decompoſition; when I ſpeak of the putrefactive fermentation I mean that in which a very conſiderable quantity of ammonia is formed.

In the ſequel of this memoir we ſhall attempt to prove that the muſcular fibre may be made to undergo different decompoſitions in which theſe principles may be differently arranged and combined and new products formed.

M. FOURCROY has given an account of the fatty matter into which he found the bodies changed in the Cimetiere des Innocens at Paris. In his firſt paper he very circumſtantially relates all the appearances which preſented on opening the graves in that church-yard. This was the burying ground of a large diſtrict wherein ſucceſſive generations of the inhabitants had been depoſited for upwards of three centuries. The remains of the human bodies, immerſed in this maſs of putreſcence were found in three different ſtates, according to the time they had been buried, the place they occupied, and their relative ſituations with regard to each other.

The moſt ancient were ſimply portions of bones, irregularly diſperſed in the ſoil, which had frequently been diſturbed. A ſecond ſtate, in certain bodies which had been always inſulated, exhibited the ſkin, the muſcles, tendons and aponeuroſes dry, hard, brittle, more or leſs grey, and ſimilar to what are called mummies, in certain caverns where this change has been obſerved, as in the catacombs at Rome, and the vault of the cordeliers at Toulouſe.

The third and moſt ſingular ſtate of theſe ſoft parts was obſerved in the bodies which fill the common graves or repoſitories. Theſe graves were thirty feet in depth and twenty on each ſide, and contained between 1000 and 1500 bodies. M. Fourcroy was preſent at the opening of one of theſe graves which had been cloſed for fifteen years. When the covers of the coffins were removed, the bodies were obſerved at the bottom, leaving a conſiderable diſtance between their ſurface and the cover, and flattened as if they had ſuffered a ſtrong compreſſion. On removing the linen which was ſlightly adherent to the bodies, irregular maſſes of a ſoft ductile matter, of a white gray colour were exhibited. The appearance of this matter, its obvious compoſition and its ſoftneſs reſembled common white cheeſe. This white ſubſtance yielded to the touch, and became ſoft when rubbed for a time between the fingers. The grave-diggers ſaid they never found this matter in bodies interred alone, but that the accumulated bodies of the common graves only were ſubject to this change.

M. Four-

M. Fourcroy, after informing us of the ſtate of the ſeveral parts of the body, proceeds with ſaying that the modifications of this fatty matter were various. Its conſiſtence in bodies lately changed, that is to ſay from three to five years, was ſoft and very ductile containing a great quantity of water. In bodies which had been longer buried this matter was drier, more brittle, and in denſer flakes: all that had been formed for a long time was white, uniform, and contained no foreign ſubſtance nor fibrous remains. In thoſe recently changed the matter was found to contain portions of muſcles, tendons and ligaments, This obſervation ſhews that it is not merely the fat which is changed.

M. Fourcroy ſhews that all the parts are at length converted, though ſome, he obſerves, paſs into this ſtate much ſooner than others. Although I have never had ſo good an opportunity of examining dead bodies as this church-yard afforded to M. Fourcroy, yet I have ſeen moſt of the phenomena which are ſo faithfully recorded by him in the foregoing memoir. It by no means requires ſo great a great length of time as M. F.'s memoir would lead us to ſuppoſe, for the converſion of the animal ſubſtance into this fatty matter. The receptacle in the anatomy ſchool at Oxford as before-mentioned, afforded me a very clear proof, that bodies expoſed to the action of water would ſoon change into this ſingular ſubſtance. I ſaw there many parts where the exterior ſurface was entirely changed, while the internal parts exhibited all the characters of muſcular fibre; indeed I have been able to mark the progreſs of the change. It is ſomewhat ſurpriſing that no one ſhould have attempted to change the freſh animal ſubſtance, after the inſtance they had of the converſion in the Cimetiere des Innocens, at Paris; the length of time which was ſuppoſed to be neceſſary, was I imagine the reaſon why experiments were not inſtituted for that purpoſe.

After I had found that water would convert animal ſubſtances into fat, I took the earlieſt opportunity of ſubmitting different animals to its influence; the reſult of ſome of the experiments, I have already brought forward.

When I find that the whole ſubſtance is not changed, I either ſubmit it again to the water or expoſe it to the air, that putrefaction may deſtroy what the water has not acted on. I have hitherto found that a year or a year and an half is quite ſufficient for changing a cow or an horſe into this matter. On taking up a third cow from a reſervoir which communicated with a river, after having been buried for little more than a year, I found the whole ſubſtance changed; the tongue was entirely converted, and the ſockets of the eyes were filled with a white matter in which could be diſtinctly traced ſeveral parts of the eye; although they were converted, they ſtill retained their original place and ſhape.

I ſhall now attempt to give an explanation of the changes which we have been conſidering, and to examine chemically what are the principles which unite to form this fatty matter.

M. Fourcroy's ſecond paper treats more particularly of the chemical properties of the ſubſtances which he diſcovered in the Cimetiere des Innocens, at Paris. It is neceſſary to mention in this place that the experiments which I have tried on the fatty matter, were made with it after I had ſeparated the pure waxy ſubſtance from thoſe parts which had not undergone the change. Theſe undecompoſed parts conſiderably affect the reſults which are afforded by analyſis, nay additional ſubſtances are found to be procured from them, ſuch as ammonia, &c.

I have already mentioned that a great length of time is neceſſary to convert all the parts of animal ſubſtances into it, ſuch as the tendons which will reſiſt the action of water, perhaps, for two years or more; hence I have found it expedient to ſeparate thoſe parts before I make any uſe of the fatty matter. The nitrous acid is the ſubſtance I make uſe of for this purpoſe, which diſſolves all the ſubſtances except the fatty matter. I have often tried M. Fourcroy's mode of purifying it, but I have not found it anſwer the purpoſe; for by ſtraining it ever ſo much ſtill a very offenſive ſmell remains; which muſt ariſe from parts which are ſtill ſubject to the putrefactive proceſs. That procured by means of the nitrous acid is free from any ſuch admixture. I have before ſhewn the degree of heat at which this ſubſtance melts; it fuſes at a much lower temperature than that of boiling water. I found no volatile alkali when I ſubmitted it to the proceſs of deſtructive diſtillation. What M. F. obtained appears to ariſe from thoſe undecompoſed parts which I have juſt deſcribed.

It has been already mentioned that in order to render this ſubſtance leſs offenſive, I expoſe it for ſome time to the action of the air, that thoſe parts which had reſiſted the action of the water might be carried off by the common proceſs of putrefaction; there is a fact recorded by M. Fourcroy which I had not then ſeen, which ſhews that the volatile alkali is not a component part of the fat, and that by expoſure to the air thoſe offenſive parts are ſeparated. He ſays that after expoſing fragments of the fatty matter to the hot and dry ſummer of 1786, they became dry, brittle, and almoſt pulverulent at the ſurface. On a careful examination he found certain portions to be ſemi-tranſparent and more brittle than the reſt. Theſe poſſeſſed all the apparent properties of wax, and did not afford the volatile alkali dy diſtillation.

I think it proper to repeat that the ammonia or volatile alkali, ariſes not from that proceſs by which the fleſh is changed into fatty matter, but from that decompoſition which ariſes from the contact of atmoſpheric air.

This is farther confirmed by another obſervation of M. Fourcroy's. He ſays, that with water the fatty matter exhibited all the appearances of ſoap, and afforded a ſtrong lather. The dried matter did not afford the ſaponaceous combination with the ſame facility or perfection as that which was recent. The reaſon appears to be this, that in one inſtance the ammonia formed with it an ammoniacal ſoap, in the other no ammonia was preſent.

We have ſaid that animal matters are ſuppoſed to be formed by a quadruple combination of oxygene, hydrogene, carbone, and azote, a certain balance of affinities, we have obſerved, is preſerved during life, after which this balance is deſtroyed, and new arrangements take place according to the influence of the circumſtances to which they are expoſed.

From M. Berthollet's experiments we learn, that the azote of the animal ſubſtance unites with the hydrogene and forms ammonia. It muſt be mentioned in this place, that when we ſay that the hydrogene unites with the azote, we do not mean that the whole of the hydrogene unites only a part of it, becauſe the remaining part flies off in the carbonated hydrogenous gas. The hydrogene continues to unite with the azote till by the azote's being ſaturated, it has not ſo great an attraction for the hydrogene as the hydrogene has for ſome other ſubſtance, and ſo of the reſt. As we cannot aſcertain the preciſe quantities of the ſubſtances which enter into the compoſition of theſe matters, it is impoſſible to aſcertain the preciſe point of ſaturation, or at what point the affinities become balanced.

The azote which abounds in animal ſubſtances, unites during putrefaction with ſome of the hydrogene, and forms with it ammonia; the carbone combines with the oxygene and forms carbonic acid, and the carbonic acid thus formed unites with the ammonia, and produces carbonate of ammonia. Another part of the carbone is diſſolved by the remaining hydrogene, and forms the carbonated-hydrogenous gas. As in every change of affinities there is a change of temperature, ſo in the preſent decompoſition the change is conſiderably affected by the degree of heat attending it.

Azote is not only the cauſe of putrefaction in animal ſubſtances, but will, when animal matters are added to vegetables promote putrefaction in them.

By pouring nitrous acid on fleſh, and keeping them together for a ſhort time, a waxy matter will be formed.

Nitrous acid has the property of driving off the azote from fleſh, the remaining ſubſtances then are oxygene, hydrogene and carbone, a triple combination of theſe three, forms the fatty matter; the nitrous acid ſuffers no change.

Before we proceed to explain the cauſe of the change which takes place when fleſh is expoſed to the action of water, it will be neceſſary to examine what takes place in nitre beds: animal and vegetable ſubſtances are there heaped together, and expoſed to peculiar circumſtances; from the one the nitrous acid is ſuppoſed to ariſe, from the other potaſh.

Here we ſee that the oxygene combines with the azote when the circumſtances of temperature and moiſture favour ſuch an arrangement. M. Lavoiſier ſays, that the oxygene is abſtracted by ſome circumſtance, when he explains the nature of the change into fat in the church-yards; but I have not found that he explains how the oxygene is ſeparated, or what becomes of it. I have already mentioned an experiment wherein oxygene was very greedily abſorbed by fleſh, this oxygene, I believe, unites with the azote, and that the nitrous acid is formed, for fleſh after having abſorbed a great quantity of oxygene will redden turnſole.

From the very ſmall quanties which I have had the power of trying, I could not aſcertain whether the nitrous acid was really the acid formed or not, but we know that nitre is produced by the decompoſition of animal matters in climates favourable to this change. Taking it for granted then, that the oxygene will unite with the azote, the change which fleſh undergoes in water will be eaſily made out. Fleſh and animal matters in general are compoſed of oxygene, hydrogene, carbone, and azote; water is compoſed of oxygene and hydrogene, and the ſubſtances which are formed, are fatty matter or a triple combination of oxygene, hydrogene, and carbone; ammonia in ſmall quantities compoſed of hydrogene and azote; carbonated hydrogenous gas compoſed of hydrogene and carbone; and nitrous acid compoſed of oxygene and azote.

The baſis of oxygene gas ſeems to form a principal ingredient in the compoſition of animal matters. There are many ways by which oxygene combines with animal matters in the living ſyſtem, the principal of which is by means of reſpiration. We have already ſeen that oxygene when united with the dead fibre determines the arrangement of the principles of which that fibre is compoſed. With the azote it forms nitrous acid, with the carbone, carbonic acid, and with the hydrogene, water. The colour of theſe ſubſtances alſo is in a great meaſure dependant on the preſence or abſence of this principle.

The baſis of hydrogene gas forms alſo a principal part of theſe ſubſtances. It is perhaps chiefly owing to the decompoſition of water that they acquire this principle.—From Count Rumford's very ingenious obſervations on food, we are led to believe that water by decompoſing in the ſtomach, affords a very conſiderable portion of the nouriſhment which animals receive.

We have already ſhewn that oxygene and hydrogene, under peculiar circumſtances, combine to form water; on this account hydrogene, by combining with the oxygene in theſe ſubſtances determines in a peculiar manner the mode of combinations between the ſeveral principles. With azote this ſubſtance forms ammonia; which alkali by uniting with the carbonic acid appears in the decompoſition of animal matters under the form of carbonate of ammonia.

The combinations of the baſis of azotic gas with the other principles we have already deſcribed, but we have to lament that we have been able to give ſuch little ſatisfaction reſpecting the agency of this moſt wonderful principle.

To this ſubſtance we muſt refer when we wiſh to mark the difference between animal and vegetable matters, and we muſt have recourſe to its influence in all the decompoſitions we have been conſidering. It is a principle which may be eaſily detached from animal matters even when alive, and I am very much diſpoſed to believe that many diſeaſes originate from the influence of this principle. From obſervations I have already made, I am led to think that I may hereafter have an opportunity of offering ſome obſervations on this principle which may elucidate the nature of ſome diſeaſes, at preſent but imperfectly underſtood.

It has been aſſerted by ſome, that the fatty matter which is produced in the decompoſition of animal ſubſtances, ariſes from a combination of hydrogene and carbone; but from the following experiment I conclude that oxygene forms a principal ingredient.—On diſtilling the fatty matter with which a quantity of carbone was mixt; a great quantity of denſe vapours aroſe, conſiſting in part of carbonic acid; now this acid I apprehend is formed from the union of the carbone with ſome of the oxygene of the fatty matter.

There ſeems to be ſome ſmall proportion of ſulphur in animal matters which appears in general in the form of ſulphurated hydrogenous gas.—The phoſphoric acid forms a principal ingregredient in the compoſition of bones, there appears to be ſome proceſs in the animal economy by which the muriatic acid is converted into the phoſphoric acid. The baſis of phoſphoric acid is one of the moſt ſingular productions in the animal economy; we have already ſhewn the mode in which a highly combuſtible body is formed from ſubſtances themſelves poſſeſſing no degree of inflammability; farther experiments may ſhew that phoſphorus itſelf is a compound reſulting from the union of ſome of the primary principles of animal ſubſtances.

Subſtances added together.

Fleſh, composed of oxygene, hydrogene, carbone, and azote;
Water ——— oxygene and hydrogene.

Subſtances formed,

Ammonia, compoſed of hydrogene and azote;
Carbonic acid ——— oxygene and carbone;
Nitrous acid ——— oxygene and azote;
Fatty matter ——— oxygene, hydrogene, and carbone;
Hydrocarbonate ——— hydrogene and carbone.

Azote favours putrefaction; hydrogene and carbonic acid retard it.

Oxygene promotes its change into fatty matter.

From all this it appears that the ſlighteſt differences either in temperature or mixture, will change the arrangement of the affinities between the remote component parts of animal ſubſtances.

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